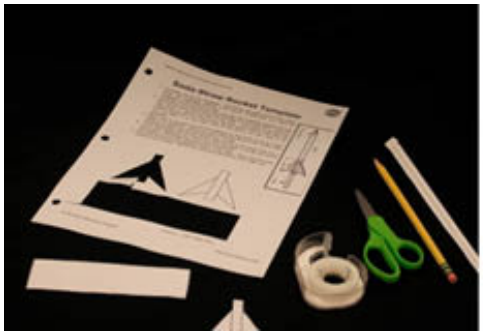
Soda Straw Rockets

3rd – 5th Grade Alignment Document
National Resource Council Framework, Next Generation Science Standards, Common Core State Standards, and 21st Century Skills



WHAT STUDENTS DO: Test a rocket model and predict its motion.

Curiosity about what lies beyond our home planet led to the first rocket launches from Earth and to many exploration missions since. Using simple materials (soda straws and paper), students will experience the processes involved in engineering a rocket. Conducting engineering tests, students will have the opportunity to answer a research question by collecting and analyzing data related to finding out the best nose cone length and predicting the motion of their model rockets.

NRC FRAMEWORK / NGSS CORE & COMPONENT QUESTIONS

HOW CAN ONE EXPLAIN AND PREDICT INTERACTIONS BETWEEN OBJECTS AND WITHIN SYSTEMS OF OBJECTS?

NRC Core Question: PS2: Motion and Stability: Forces and Interactions

How can one predict an object's continued motion, changes in motion, or stability?

NRC PS2.A: Forces and Motions

What underlying forces explain the variety of interactions observed?

NRC PS2.B: Types of Interactions

HOW DO ENGINEERS SOLVE PROBLEMS?

NRC Core Question: ETS1: Engineering Design

What is a design for? What are the criteria and constraints of a successful solution?

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Plan and conduct an investigation into the effects of forces on the distance and path traveled of a soda straw rocket using empirical evidence to explain the impact of a net force on an object.

Last edited: January 27, 2016

NRC ETS1.A: Defining and Delimiting an Engineering Problem

What is the process for developing potential design solutions?

NRC ETS1.B: Developing Possible Solutions

How can the various proposed design solutions be compared and improved?

NRC ETS1.C: Optimizing the Design Solution

Last edited: January 27, 2016

1.0 About This Activity

The Mars lessons leverage *A Taxonomy for Learning, Teaching, and Assessing* by Anderson and Krathwohl (2001) (see *Section 4* and *Teacher Guide* at the end of this document). This taxonomy provides a framework to help organize and align learning objectives, activities, and assessments. The taxonomy has two dimensions. The first dimension, cognitive process, provides categories for classifying lesson objectives along a continuum, at increasingly higher levels of thinking; these verbs allow educators to align their instructional objectives and assessments of learning outcomes to an appropriate level in the framework in order to build and support student cognitive processes. The second dimension, knowledge, allows educators to place objectives along a scale from concrete to abstract. By employing Anderson and Krathwohl's (2001) taxonomy, educators can better understand the construction of instructional objectives and learning outcomes in terms of the types of student knowledge and cognitive processes they intend to support. All activities provide a mapping to this taxonomy in the Teacher Guide (at the end of this lesson), which carries additional educator resources. Combined with the aforementioned taxonomy, the lesson design also draws upon Miller, Linn, and Gronlund's (2009) methods for (a) constructing a general, overarching, instructional objective with specific, supporting, and measurable learning outcomes that help assure the instructional objective is met, and (b) appropriately assessing student performance in the intended learning-outcome areas through rubrics and other measures. Construction of rubrics also draws upon Lanz's (2004) guidance, designed to measure science achievement.

How Students Learn: Science in the Classroom (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. This five-part sequence is the organizing tool for the Mars instructional series. The 5E stages can be cyclical and iterative.

2.0 Instructional Objectives, Learning Outcomes, & Standards

Instructional objectives and learning outcomes are aligned with

- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- Achieve Inc.'s, *Next Generation Science Standards (NGSS)*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and* Technical Subjects
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

The following chart provides details on alignment among the core and component NGSS questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NGSS Framework and NGSS.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics** (see Teacher Guide at the end of this document).

Important Note: This lesson is color-coded to help teachers identify each of the three dimensions of NGSS. The following identifying colors are used: Practices are blue, Cross-Cutting Concepts are green, and Disciplinary Core Ideas are orange.

This color-coding is consistent with the NGSS Performance Expectations and Foundation Boxes.

Quick View of Standards Alignment:

The Teacher Guide at the end of this lesson provides full details of standards alignment, rubrics, and the way in which instructional objectives, learning outcomes, 5E activity procedures, and assessments were derived through, and align with, Anderson and Krathwohl's (2001) taxonomy of knowledge and cognitive process types. For convenience, a quick view follows:

HOW CAN ONE EXPLAIN AND PREDICT INTERACTIONS BETWEEN OBJECTS AND WITHIN SYSTEMS OF OBJECTS?

NGSS Core Question: PS2: Motion and Stability: Forces and Interactions

How can one predict an object's continued motion, changes in motion, or stability?

NGSS PS2.A: Forces and Motion

What underlying forces explain the variety of interactions observed?

NRC PS2.B: Types of Interactions

HOW DO ENGINEERS SOLVE PROBLEMS?

NGSS Core Question: ETS1: Engineering Design

What is a design for? What are the criteria and constraints of a successful solution?

NGSS ETS1.A: Defining and Delimiting an Engineering Problem

What is the process for developing potential design solutions?

NGSS ETS1.B: Developing Possible Solutions

How can the various proposed design solutions be compared and improved?

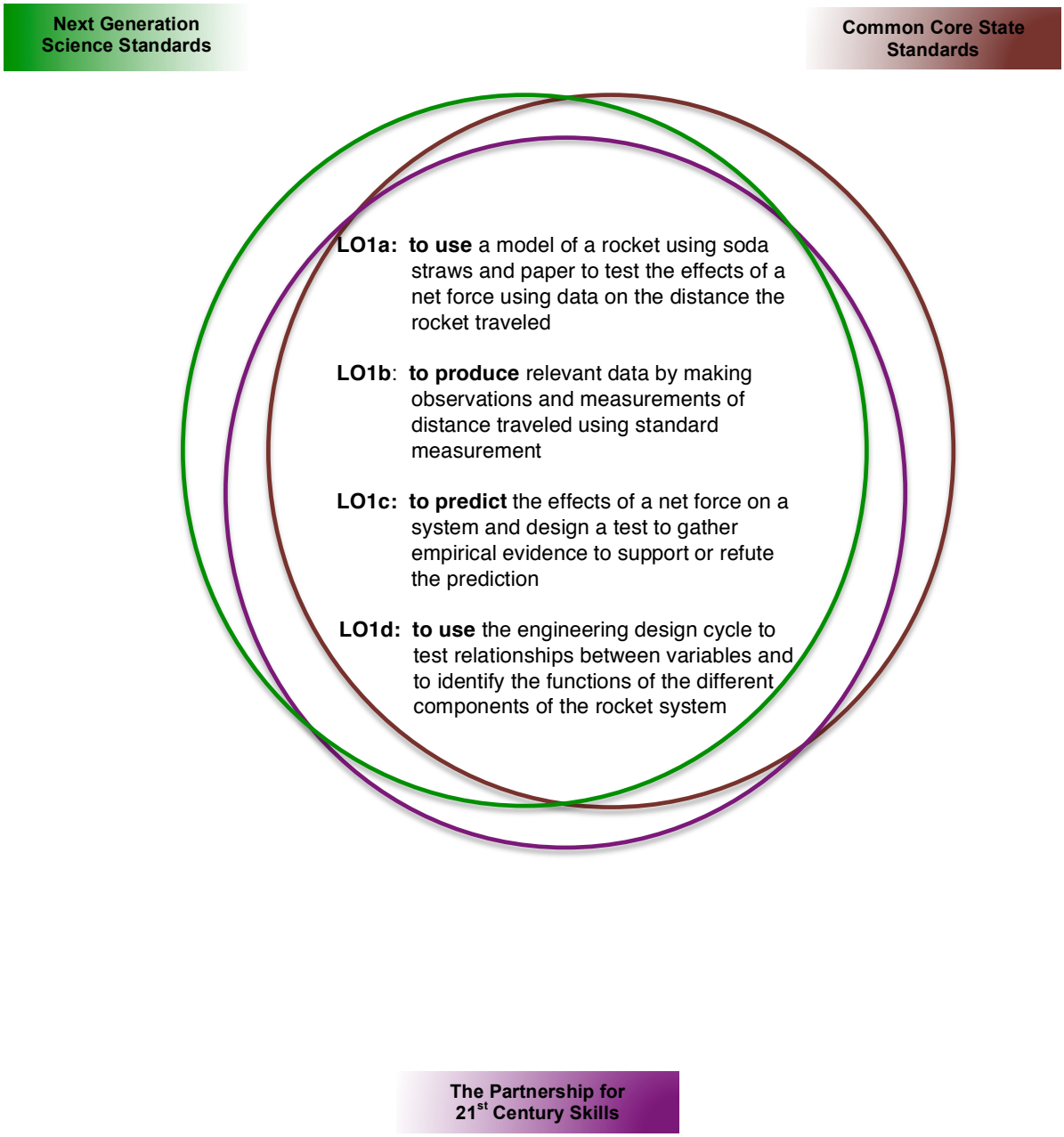
NGSS ETS1.C: Optimizing the Design Solution

Instructional Objective (IO) *Students will be able to:*	**Learning Outcomes (LO)** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*
IO1: **Plan and conduct an investigation through construction of a model rocket using soda straws and paper to test the effects of a push and of design changes of a rocket on the distance of travel**	**LO1a: to use a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled** **LO1b: to produce relevant data by making observations and measurements of distance traveled using standard measurement** **LO1c: to predict the effects of a net force on a system and design a test to gather empirical evidence to support or refute the prediction** **LO1d: to use the engineering design cycle to test relationships between variables and to identify the functions of the different components of the rocket system**	**DISCIPLINARY CORE IDEAS:** **PS2.A: Forces and Motion** **PS2.B: Types of Interactions** **ETS1.A: Defining and Delimiting Engineering Problems** **ETS1.B: Developing Possible Solutions** **ETS1.C: Optimizing the Design Solution** **PRACTICES:** 1. **Asking Questions and Defining Problems** 2. **Developing and Using Models** 3. **Planning and Carrying out Investigations** 4. **Analyzing and Interpreting Data** 5. **Using Mathematics and Computational Thinking** 6. **Constructing Explanations and Designing Solutions** 7. **Engaging in Argument from Evidence** 8. **Obtaining, Evaluating, and Communicating Information** **Scientific Knowledge is Based on Empirical Evidence** **CROSSCUTTING CONCEPTS:** 1. **Cause and Effect: Mechanism and Prediction** 2. **Scale, Proportion and Quantity** 3. **Systems and System Models** **Science Addresses Questions about the Natural and Material World**

Last edited: January 27, 2016

3.0 Learning Outcomes, NGSS, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the learning outcomes addressed in the lesson to establish where each will meet the Next Generation Science Standards, ELA Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents.



4.0 Evaluation/Assessment

Use the *(L) Soda Straw Rockets Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the Next Generation Science Standards, Common Core State Standards, and 21st Century Skills.

5.0 References

Achieve, Inc. (2013). *Next generation science standards*. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications.* Colorado Springs: BSCS.

Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom.* Washington, DC: The National Academies Press.

Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.

National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The Partnership for 21st Century Skills (2011). *A framework for 21st century learning.* Retrieved March 15, 2012 from http://www.p21.org

(I) Teacher Resource. Soda Straw Rockets NGSS Alignment (1 of 3)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

Related Standard(s)

This lesson supports the preparation of students toward achieving Performance Expectations using the Practices, Cross-Cutting Concepts and Disciplinary Core Ideas defined below:
(3-PS2-1), (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)

Next Generation Science Standards Alignment (NGSS)

Instructional Objective *Students will be able to*	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
IO1: **Plan and conduct an investigation into the effects of forces on the distance and path traveled of a soda straw rocket using empirical evidence to explain the impact of a net force on an object.**	**Asking Questions and Defining Problems:** Ask questions about what would happen if a variable is changed. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. **Developing and Using Models:** Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other. **ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Science Addresses Questions about the Natural and Material World** Science findings are limited to what can be answered with empirical evidence.

	Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. **Analyzing and Interpreting Data:** Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Use data to evaluate and refine design solutions. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. **Constructing Explanations and Designing Solutions:** Construct an explanation of observed	success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	

	relationships (e.g., the distribution of plants in the back yard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Identify the evidence that supports particular points in an explanation. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect. **Scientific Knowledge is Based on Empirical Evidence:** Science findings are based on recognizing patterns. **Science Addresses Questions About the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.		

(I) Teacher Resource. Soda Straw Rockets NGSS Alignment (2 of 3)

Next Generation Science Standards Alignment (NGSS)

Instructional Objective *Students will be able to*	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
LO1a: to use a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled	**Developing and Using Models:** Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. **Using Mathematics and Computational Thinking:**	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other. **ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Science Addresses Questions about the Natural and Material World** Science findings are limited to what can be answered with empirical evidence.

	Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. **Engaging in Argument from Evidence:** Use data to evaluate claims about cause and effect. **Science Addresses Questions About the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.	problem, given the criteria and the constraints.	
LO1b: to produce relevant data by making observations and measurements of distance traveled using standard measurement	**Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. **Science Addresses Questions About the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other.	**Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Science Addresses Questions about the Natural and Material World** Science findings are limited to what can be answered with empirical evidence.

LO1c: to predict the effects of a net force on a system and design a test to gather empirical evidence to support or refute the prediction	**Asking Questions and Defining Problems:** Ask questions about what would happen if a variable is changed. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. **Developing and Using Models:** Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other. **ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Systems and System Models:** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions. **Science Addresses Questions about the Natural and Material World** Science findings are limited to what can be answered with empirical evidence.

	Analyzing and Interpreting Data: Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Use data to evaluate and refine design solutions. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. **Constructing Explanations and Designing Solutions:** Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Identify the evidence that supports particular points in an explanation. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect. **Obtaining, Evaluating, and Communicating Information:** Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as		

	tables, diagrams, and charts. **Scientific Knowledge is Based on Empirical Evidence:** Science findings are based on recognizing patterns. **Science Addresses Questions About the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.		
LO1d: to use the engineering design cycle to test relationships between variables and to identify the functions of the different components of the rocket system	**Asking Questions and Defining Problems:** Ask questions about what would happen if a variable is changed. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. **Developing and Using Models:** Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other. **ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Systems and System Models:** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.

	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes. Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. **Analyzing and Interpreting Data:** Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Use data to evaluate and refine design solutions. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. **Constructing Explanations and Designing Solutions:** Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. Identify the evidence that supports particular points in an explanation.	problem, given the criteria and the constraints.	

	Engaging in Argument from Evidence: Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect. **Obtaining, Evaluating, and Communicating Information:** Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. **Scientific Knowledge is Based on Empirical Evidence:** Science findings are based on recognizing patterns. **Science Addresses Questions About the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.		

(I) Teacher Resource. Soda Straw Rockets NGSS Activity Alignment (3 of 3)

Next Generation Science Standards Activity Alignments (NGSS)				
Activity	**Phases of 5E Instructional Model**	**Science and Engineering Practices**	**Disciplinary Core Idea**	**Crosscutting Concepts**
Research Common Rocket Features	**Engage**	**Planning and Carrying Out Investigations:** Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change.
(A) Soda-Straw Rocket Template	**Explore**	**Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. **Developing and Using Models:** Develop and/or use models to describe and/or predict phenomena.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change.
(B) Safety Procedure				

(C) Forces and Net Forces Explained	**Explore**	**Developing and Using Models:** Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. Develop and/or use models to describe and/or predict phenomena. **Planning and Carrying Out Investigations:** Make predictions about what would happen if a variable changes. **Constructing Explanations and Designing Solutions:** Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Systems and System Models:** A system can be described in terms of its components and their interactions.
(D) Soda-Straw Rocket Initial Results	**Explore**	**Developing and Using Models:** Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

		Constructing Explanations and Designing Solutions: Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). **Scientific Knowledge is Based on Empirical Evidence:** Science findings are based on recognizing patterns. Scientists use tools and technologies to make accurate measurements and observations.		
(E) Soda-Straw Rocket Engineering Design	**Explore** **Elaborate**	**Asking Questions and Defining Problems:** Ask questions about what would happen if a variable is changed. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. **Planning and Carrying Out Investigations:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	**PS2.A: Forces and Motion:** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. **PS2.B: Types of Interactions:** Objects in contact exert forces on each other. **ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

		Scientific Knowledge is Based on Empirical Evidence: Science findings are based on recognizing patterns. Scientists use tools and technologies to make accurate measurements and observations.	important part of the design process, and shared ideas can lead to improved designs.	
(F) Soda-Straw Rocket Engineering Design Conclusions	**Explain**	**Asking Questions and Defining Problems:** Ask questions about what would happen if a variable is changed. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. **Planning and Carrying Out Investigations:** Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. Use data to evaluate claims about cause and effect.	**ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.B: Developing Possible Solutions:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	**Cause and Effect: Mechanism and Prediction** Cause and effect relationships are routinely identified, tested, and are used to explain change. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.
(G) Soda-Straw Rocket Engineering Design Evaluation	**Evaluate**	**Asking Questions and Defining Problems:** Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	**ETS1.A: Defining and Delimiting: Engineering Problems:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria).	**Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.

		Constructing Explanations and Designing Solutions: Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. **ETS1.C: Optimizing the Design Solution:** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	**Systems and System Models:** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

(J) Teacher Resource. Soda Straw Rockets CCSS Alignment (1 of 2)

Common Core State Standards			
Instructional Objective *Students will be able to*	**Reading Standards for Informational Text (3-5)**	**Writing Standards (3-5)**	**Speaking and Listening Standards (3-5)**
IO1: **Plan and conduct an investigation through construction of a model rocket using soda straws and paper to test the effects of a push and of design changes of a rocket on the distance of travel**	**Key Ideas and Details:** **Grade 3:** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. **Grade 4:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. **Grade 5:** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. **Craft and Structure:** **Grade 3:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area. Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. **Grade 4:** Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area. **Grade 5:** Determine the meaning of general academic and domain-specific words and phrases in a text	**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

	relevant to a grade 5 topic or subject area. **Integration of Knowledge and Ideas:** **Grade 3:** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). **Grade 4:** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **Grade 5:** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.	specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information,	a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

		and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 4 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text"). **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").	

(J) Teacher Resource. Soda Straw Rockets CCSS Alignment (2 of 2)

Common Core State Standards			
Learning Outcome *Students will be able*	**Reading Standards for Informational Text (3-5)**	**Writing Standards (3-5)**	**Speaking and Listening Standards (3-5)**
LO1a: **to use a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled**			**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-

			led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
LO1b: **to produce**			**Comprehension and Collaboration:** **Grade 3:**

relevant data by making observations and measurements of distance traveled using standard measurement			Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and

			explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
LO1c: **to predict the effects of a net force on a system and design a test to gather empirical evidence to support or refute the prediction**		**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).

		a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:**	c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

		Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 4 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text"). **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").	b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

LO1d: **to use the engineering design cycle to test relationships between variables and to identify the functions of the different components of the rocket system**	**Key Ideas and Details:** **Grade 3:** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. **Grade 4:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. **Grade 5:** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. **Craft and Structure:** **Grade 3:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area. Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. **Grade 4:** Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area. **Grade 5:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area. **Integration of Knowledge and Ideas:** **Grade 3:** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). **Grade 4:** Interpret information presented visually, orally, or	**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. e. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. f. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). g. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. h. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. e. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. f. Follow agreed-upon rules for discussions and carry out assigned roles. g. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to

	quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **Grade 5:** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.	group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 4 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text").	the discussion and link to the remarks of others. h. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. e. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. f. Follow agreed-upon rules for discussions and carry out assigned roles. g. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. h. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

		Grade 5: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").	

(J) Teacher Resource. Soda Straw Rockets 21st Century Skills Alignment

21st Century Skills			
Learning Outcomes *Students will demonstrate the measurable abilities*	**21st Century Skill**	**Grade 4 Benchmark**	**Grade 8 Benchmark**
LO1a: **to use a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled**	**Communication**	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.	
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.
	Productivity & Accountability		Students can articulate the importance of accurate data collection and record keeping in science, and are able to demonstrate good practices for data collection, and identify common sources of error.
LO1b: **to produce relevant data by making observations and measurements of distance traveled using standard measurement**	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.	
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.	
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.

	Productivity & Accountability		Students can articulate the importance of accurate data collection and record keeping in science, and are able to demonstrate good practices for data collection, and identify common sources of error.
LO1c: **to predict the effects of a net force on a system and design a test to gather empirical evidence to support or refute the prediction**	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.	
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.	
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.
	Productivity & Accountability		Students can articulate the importance of accurate data collection and record keeping in science, and are able to demonstrate good practices for data collection, and identify common sources of error.
LO1d: **to use the engineering design cycle to test relationships between variables and to identify the functions of the different components of the rocket system**	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.	
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.	
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.
	Initiative & Self Direction	Students are able to design an investigation based on a question they have generated from their own curiosity.	

	Productivity & Accountability		Students can articulate the importance of accurate data collection and record keeping in science, and are able to demonstrate good practices for data collection, and identify common sources of error.

(L) Teacher Resource. Soda Straw Rockets NGSS Rubric (1 of 3)

Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

Next Generation Science Standards Alignment (NGSS)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a. to use a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled	Consciously identifies and controls essential variables to test each variable's effect on distance traveled. Uses data to support cause/effect relationships. Model construction and modifications are carefully done to eliminate errors.	Controls variables (e.g. angle of launch) while varying force (of blowing) on rocket. Performs several tests at each level of force on rocket Model is constructed well. Data collection is consistent.	Controls most variables (e.g. angle of launch) while varying force (of blowing) on rocket. Model is constructed adequately, although some construction errors affect performance of model.	Relies on group members to construct the rocket and may be in charge of rocket launches. Group members participate in modeling while student awaits instruction.
LO1b: to produce relevant data by making observations and measurements of distance traveled using standard measurement	Observations and measurements are consciously chosen to produce the most relevant data for determining distance traveled. Measurements are very accurate and appropriate tools are used. SI units are used for measurement.	Observations and measurements are relevant to problem. Measurements are reasonably accurate and appropriate tools are used. Standard units of measurement are used.	Most observations and measurements are relevant to problem. Measurements are relatively accurate and most tools are appropriate to the task.	Relies on group members to participate in decisions on data collection and awaits instruction from the group or does not participate in data collection.
LO1c: to predict the effects of a net force on a system and **design** a test to gather empirical evidence to support or refute the prediction	Prediction is logical and based on evidence and shows insightful interpretation of the data. The test is designed to gather only evidence that will prove or disprove the prediction.	Prediction is logical and based on evidence from prior examinations of the soda straw model. The test is design to gather evidence to test prediction.	Prediction is logical and uses some evidence from prior examinations of soda straw model. The test is designed to gather some evidence to test the prediction.	Prediction is written and based on personal preferences. Other group members designed the test with little to no input.

LO1d: to use the engineering design cycle to test relationships between variables and **to identify** the functions of the different components of the rocket system	Describes how they used the engineering design cycle to plan modifications and test those modifications. Discusses the results of the test of the modifications and uses that data to identify the functions of the different components of the rocket system.	Describes how they used the engineering design cycle to plan modifications and test those modifications. Discusses the results of the test of the modifications in terms of the modifications made. (e.g. when we did this, this happened.)	Accurately describes how some aspects of the engineering design cycle (in isolation) were used in modifying the rocket. May address the function of individual components in the description.	Provides a general description of the activity with little to no reference to the engineering design cycle or how individual components function in relationship to the rocket.

(L) Teacher Resource. Soda Straw Rockets CCSS Rubric (2 of 3)

Common Core – ELA

	Expert	Proficient	Intermediate	Beginner
Key Ideas and Details	Uses specific evidence from text to support ideas. Develops an accurate and in depth summary, extending prior understanding and opinions.	Uses specific evidence from text to support ideas. Develops an in depth summary, extending prior understanding and opinions.	Uses information from text to support ideas. Develops a summary, extending prior understanding and opinions.	Supports ideas with details, relying on prior knowledge and opinions.
Craft and Structure	Determines and uses domain-specific words and phases from text to accurately support ideas.	Determines and uses domain-specific words and phrases from text to support ideas.	Uses domain-specific words and phrases from text with occasional errors to support ideas.	Uses standard language to support ideas.
Integration of Knowledge and Ideas	Uses a combination of drawing, dictating, and writing to provide a description of the results of the experiment, supported with evidence from the experiment.	Uses a combination of drawing, dictating, and writing to describe the results of the experiment.	Uses a drawing, dictation, or writing to describe the results of the experiment.	Description of the result is based on prior knowledge or preconceptions.
Text Type and Purposes	Uses a combination of drawing, dictating, and writing to describe the results of the experiment, supported with facts about the experiments, and a closing statement about the experiment.	Uses drawing, dictating, or writing to describe the results of the experiment, supported with facts about the experiments, and a closing statement about the experiment.	Uses drawing, dictating, or writing to describe the results of the experiment and is supported with facts about the experiments.	Uses drawing, dictating, or writing to provide the results of the experiment.
Research to Build and Present Knowledge	Recalls relevant information from research project and experiment sorting evidence into appropriate categories. Provides a list of sources (4^{th} – 5^{th} grade).	Recalls relevant information from research project and experiment. Provides a list of sources (4^{th} – 5^{th} grade).	Recalls information from research project or from the experiment. May provide a list of sources (4^{th} – 5^{th} grade).	Uses prior knowledge or preconceptions.

Comprehension and Collaboration	Clearly articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Extremely prepared drawing from experiences. Asks clarifying questions to ensure full understanding of content. Articulates own ideas related to the discussion and connects others ideas to own.	Articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Prepared for discussion by drawing from experiences. Asks questions. Articulates own ideas related to the discussion.	Interested in collaborative discussion. Asks questions. Articulates own ideas related to the discussion.	Interested in collaboration with peers.

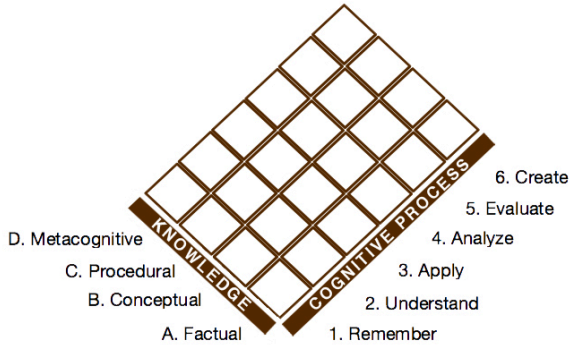
(L) Teacher Resource. Soda Straw Rockets 21st Century Skills Rubric (3 of 3)

Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
Effectiveness of collaboration with team members and class.	Extremely interested in collaborating in the group. Actively provides solutions to problems, listens to suggestions from others, and attempts to ensure everyone has a contribution.	Extremely Interested in collaborating in the group. Actively provides suggestions and occasionally listens to suggestions from others.	Interested in collaborating in the group. Listens to suggestions from peers and attempts to use them. Occasionally provides suggestions in group discussion.	Interested in collaborating in the group or spend majority of the time off topic.
Effectiveness of Critical Thinking and Problem Solving	Develops detailed verbal explanations based on experimental evidence. Compares explanations to those made by peers and relates them to their new understandings.	Develops detailed verbal explanations based on experimental evidence. Relates them to their new understandings.	Develops verbal explanations. Relates explanation to their new understandings.	Attempts to explain the design based on own preconceived understanding or generally agree with the explanations provided by the group.
Effectiveness in Communication	Demonstrates the understanding that the paper rocket is a simple model of a real rocket, not all components of the rocket are represented, and communication is rooted in reality, not make-believe.	Demonstrates the understanding that the paper rocket is a simple model of a real rocket, not all components of the rocket are represented, and may pretend the rocket is real, but majority of the experiment is rooted in reality.	Demonstrates the understanding that the paper rocket is a simple model of a real rocket and may pretend the rocket is real, but majority of the experiment is rooted in reality.	Plays with the rocket regardless of the goals of the task
Effectiveness of Initiative and Self-Direction	Designs an investigation based on a question they have generated as a result of their experiment with push vs. distance.	Designs an investigation based on a question generated by another group and is the result of the experiment with push vs. distance.	Designs an investigation based on a question generated by the teacher and is the result of the experiment with push vs. distance.	Plays with the rocket regardless of the goals of the task
Effectiveness of Productivity and Accountability	Accurately collects data and able to demonstrate good practices for data collection such as using standard measurement with correct tools **and** identifying common sources of error.	Accurately collects data and able to demonstrate good practices for data collection such as using standard measurement with correct tools **or** identifying common sources of error.	Accurately collects data.	Records data other team members have collected.

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)

This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.

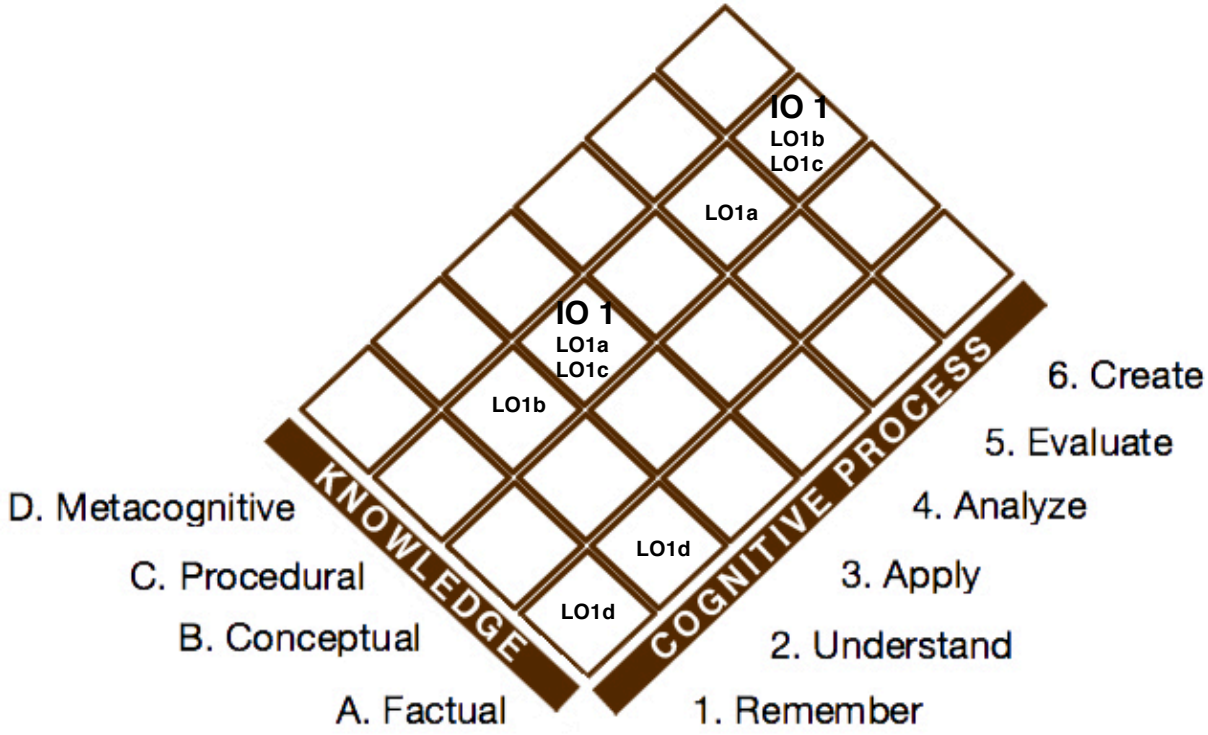


Knowledge	Cognitive Process
A. Factual **Aa:** Knowledge of Terminology **Ab:** Knowledge of Specific Details & Elements **B. Conceptual** **Ba:** Knowledge of classifications and categories **Bb:** Knowledge of principles and generalizations **Bc:** Knowledge of theories, models, and structures **C. Procedural** **Ca:** Knowledge of subject-specific skills and algorithms **Cb:** Knowledge of subject-specific techniques and methods **Cc:** Knowledge of criteria for determining when to use appropriate procedures **D. Metacognitive** **Da:** Strategic Knowledge **Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge **Dc:** Self-knowledge	**1. Remember** **1.1** Recognizing (Identifying) **1.2** Recalling (Retrieving) **2. Understand** **2.1** Interpreting (Clarifying, Paraphrasing, Representing, Translating) **2.2** Exemplifying (Illustrating, Instantiating) **2.3** Classifying (Categorizing, Subsuming) **2.4** Summarizing (Abstracting, Generalizing) **2.5** Inferring (Concluding, Extrapolating, Interpolating, Predicting) **2.6** Comparing (Contrasting, Mapping, Matching) **2.7** Explaining (Constructing models) **3. Apply** **3.1** Executing (Carrying out) **3.2** Implementing (Using) **4. Analyze** **4.1** Differentiating (Discriminating, distinguishing, focusing, selecting) **4.2** Organizing (Finding coherence, integrating, outlining, parsing, structuring) **4.3** Attributing (Deconstructing) **5. Evaluate** **5.1** Checking (Coordinating, Detecting, Monitoring, Testing) **5.2** Critiquing (Judging) **6. Create** **6.1** Generating (Hypothesizing) **6.2** Planning (Designing) **6.3** Producing (Constructing)

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

IO1: Plan and conduct an investigation through construction of a model rocket using soda straws and paper to test the effects of a push and of design changes of a rocket on the distance of travel (6.2, 3.1; Cb)

LO1a. **to use** a model of a rocket using soda straws and paper to **test** the effects of a net force using data on the distance the rocket traveled (3.2, 5.1; Cb)
LO1b. **to produce** relevant data by making observations and measurements of distance traveled using standard measurement (6.3; Cb)
LO1c. **to predict** the effects of a net force on a system and **design** a test to gather empirical evidence to support or refute the prediction (2.5, 6.2; Cb)
LO1d. **to use** the engineering design cycle to test relationships between variables and **to identify** the functions of the different components of the rocket system (2.5, 1.1; Ab)



(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (3 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see 5.0 Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to (M, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (M, 2 of 3) provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

At the end of the lesson, students will be able

IO1: **Plan and conduct** an investigation through construction of a model rocket using soda straws and paper to test the effects of a push and of design changes of a rocket on the distance of travel
- **6.2:** to plan
- **3.1:** to conduct
- **Cb:** Knowledge of subject-specific techniques and methods

To meet that instructional objective, students will demonstrate the abilities:

LO1a: **to use** a model of a rocket using soda straws and paper to test the effects of a net force using data on the distance the rocket traveled
- 3.2: to use
- 5.1: to test
- Cb: Knowledge of subject-specific techniques and methods

LO1b: **to produce** relevant data by making observations and measurements of distance traveled using standard measurement
- 6.3: to produce
- Cb: Knowledge of subject-specific techniques and methods

LO1c: **to predict** the effects of a net force on a system and **design** a test to gather empirical evidence to support or refute the prediction
- 2.5: to use
- 6.2: to design
- Cb: Knowledge of subject-specific techniques and methods

LO1d: **to use** the engineering design cycle to test relationships between variables and **to identify** the functions of the different components of the rocket system
- 2.5: to use
- 1.1: to identify
- **Ab:** Knowledge of Specific Details & Elements